
Space Weather Technical Forecast

Issued on Sunday, 01 October 2023 at 01:28 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: Chance of M-flares throughout. Chance of G1 Minor Storm conditions on day 2 (02 Oct). Chance of Active High Energy Electron Fluence on day 1 (01 Oct).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Moderate with frequent C-class flares and a single M-class event, peaking at M1.2 at 30/1635 UTC from AR3451 in the far northeast. There are eight sunspot regions on the disc. The most notable regions are the two sunspots in the northeast, the northernmost of which has been numbered AR3451. Both continue to show ongoing development, and as they move into a less oblique viewing angle there are small delta spots visible in each region. The two regions are also close enough to have some potential interaction between them. Otherwise AR3449 persists as a small and slightly complex region (with a Beta-Gamma configuration) now moving into the northwest disc. AR3450 in the southeast is the largest region but remains relatively simple, despite some modest increase in size. There is some magnetic looping evident in SDO imagery at, or just over the eastern limb in both hemispheres, suggesting further regions may be close to rotating onto the visible disc.

No Earth-directed CMEs have been observed, however a very faint CME was identified from a disappearing solar filament (dsf) around 30/0350 UTC from the southeast disc. This is passing behind (east) and south of Earth.

Solar Wind / Geomagnetic Activity: Solar winds, as observed by ACE at L1, have eased from slightly elevated levels to near background, reducing from around 430km/s to 390-400km/s during the period. Density was below average. The interplanetary magnetic field (IMF), Bt, was weak, easing from 7nT to around 5nT. The north-south component, Bz, has been largely negative, varying between +5nT and -5nT. Phi angle was generally positive (away from the Sun), until around 30/1500 UTC, when occasional periods of negative (towards the Sun) phi angle were observed. Resultant geomagnetic activity was Quiet to Unsettled (Kp 1-3).

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux was at background levels. GOES16 high energy (greater than 2MeV) was Moderate to High for much of the period, reaching a peak of 2210pfu at 30/1600 UTC, but has since reduced back to Moderate to background levels. Associated 24-hour fluence was initially just below the Active (1e8 integrated pfu) threshold, but rose above this level between 30/0600-1800 UTC. The observation at 01/0000 UTC was 7.51e7 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Low to Moderate with a chance of further isolated M-class flares.

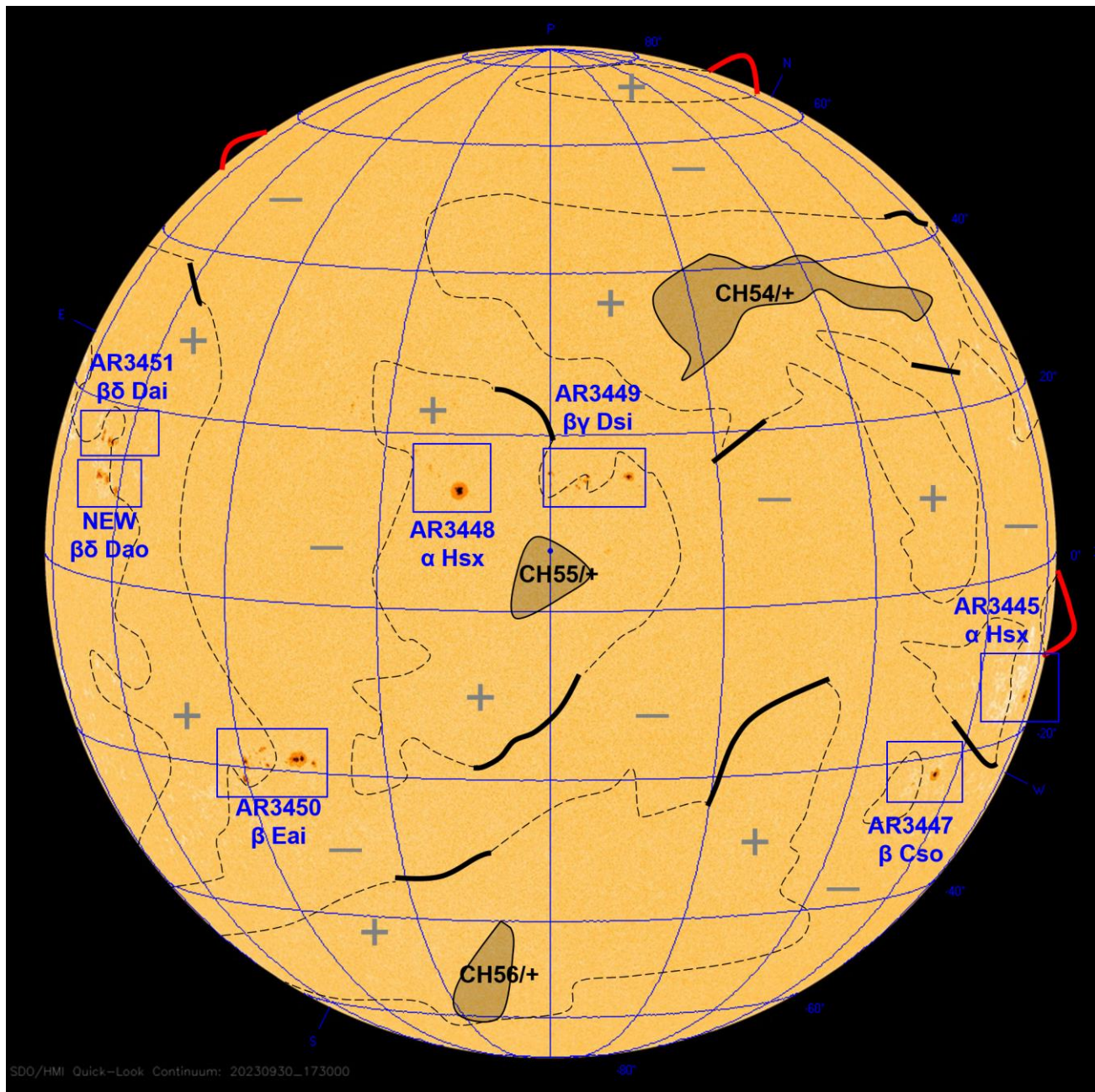
Solar Wind / Geomagnetic Activity: There are no Earth-directed CMEs. The next notable enhancement is most likely to occur on day 2 (02 Oct) due to the arrival of the fast winds of CH54/+. This feature is currently in the northwest disc, but with a southeastern extended lobe that has a greater potential for a geoeffective connection on day 2 (02 Oct). A further, small coronal hole enhancement (CH55/+) is possible on day 4 (04 Oct). Geomagnetic activity is expected to be Quiet to Unsettled on day 1 (01 Oct), then Quiet to Active between days 2-4 (02-

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04 Oct) with a chance of G1 Minor Storms on day 2 (02 Oct) and day 4 (04 Oct).

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux is expected to remain at Background levels, with no Solar Radiation storms expected. High energy electron flux (greater than 2MeV) is expected to vary between background and diurnally high levels on day 1 (01 Oct) and some of day 2 (02 Oct). Thereafter a more significant drop-out of electron flux is forecast, related to the onset of coronal hole fast winds. A positive response in electron flux is possible by day 4 (04 Oct), although could be short-lived as further fast wind enhancements could again cause drop-out. Fluence is just below Active (above $1e8$ integrated pfu) levels to start day 1 (01 Oct) and is expected to remain below throughout on a generally decreasing trend.

Figure 1. Solar Analysis Valid 30/1730 UTC.



Key: Filament — , Prominence — , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α - β - $\beta\gamma$ - $\beta\gamma\delta$ and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

There are no Earth-directed CMEs.

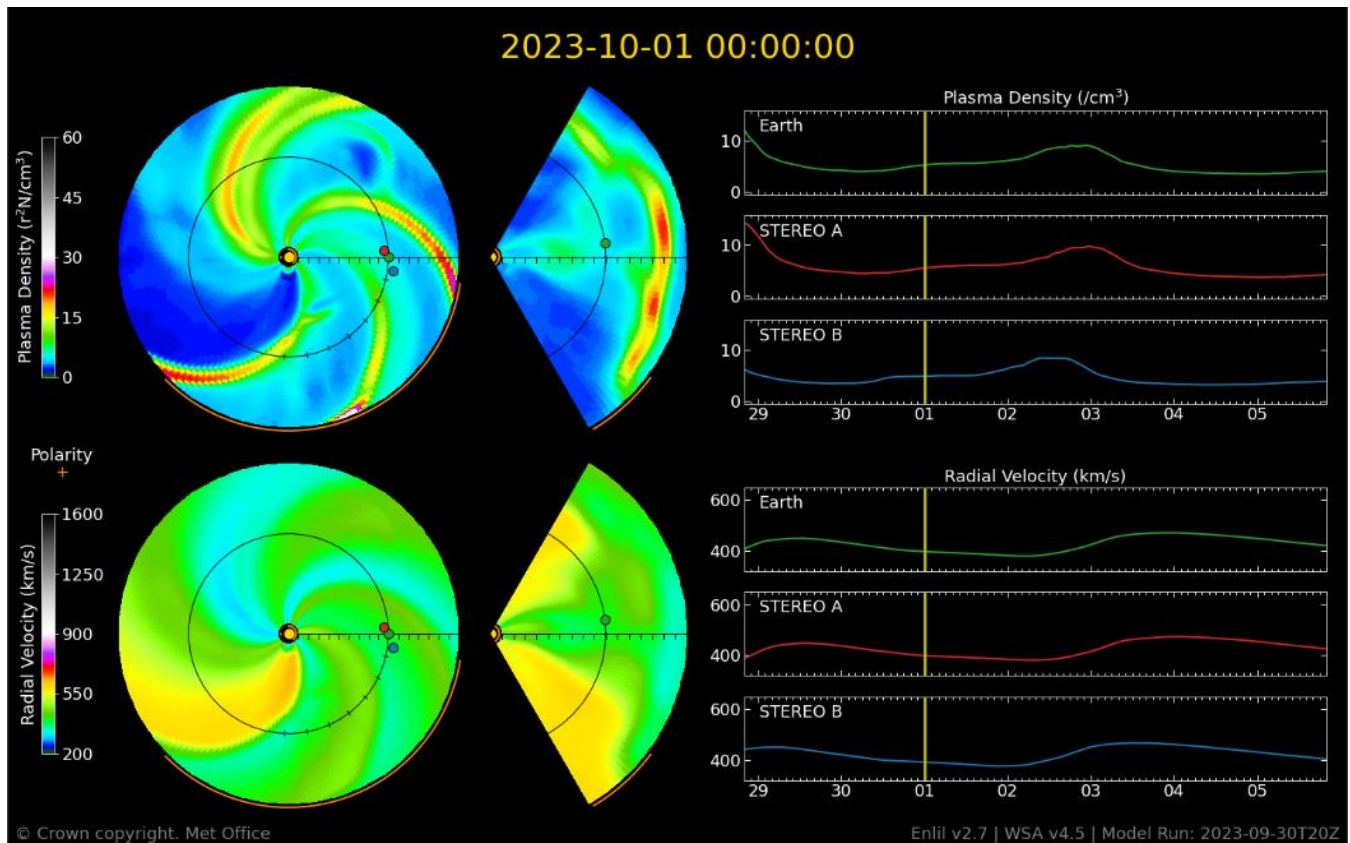
Solar winds are currently around background to slightly elevated levels, with Earth likely south of any notable fast wind influence from CH54/+. This is a broad feature in terms of longitudinal extent, located at mid-high latitudes across the northwestern disc, although a southeastern extended lobe may allow for a transition into its fast wind on day 2 (02 Oct), perhaps bringing speeds up to around 500 km/s. Considering its positive polarity, this is more favoured for a geoeffective connection at this time of year, bringing an increased potential for enhanced geomagnetic activity and is broadly in-line with the current MOSWOC enlil forecast. On day 4 (04 Oct) a connection to the high-speed stream of equatorial CH55/+ is possible. This is a small, non-recurrent feature, therefore any speed increases that might be observed are uncertain. Tentatively, slightly elevated speeds are most likely to occur from this.

Geomagnetic activity is expected to be Quiet to Unsettled on day 1 (01 Oct), then Quiet to Active between days 2-4 (02-04 Oct) with a chance of G1 Minor Storms on day 2 (02 Oct) and day 4 (04 Oct).

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	5	30	10	20
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections - Nil

Figure 2: Latest Enlil model output



Radio Blackouts - X-Ray Flares:

Low to Moderate activity is forecast, with a chance for further isolated M-flares, either from the eight sunspot regions, or from any new region rotating onto the disc from over the eastern limb.

The most notable regions are the two sunspots in the northeast, the northernmost of which has been numbered AR3451. This region was responsible for an M1.2 flare at 30/1635 UTC. Both continue to show ongoing development, and as they move into a less oblique viewing angle there are small delta spots visible in each region. The two regions are also close enough to have some potential interaction between them. Otherwise AR3449 persists as a small and slightly complex region now moving into the northwest disc, while AR3450 in the southeast is the largest region but remains relatively simple. Further regions are also likely to rotate onto the northeast and southeast disc in the coming days.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	50	50	50	50
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 3: GOES 16 and 18 X-ray flux from past 24 hours

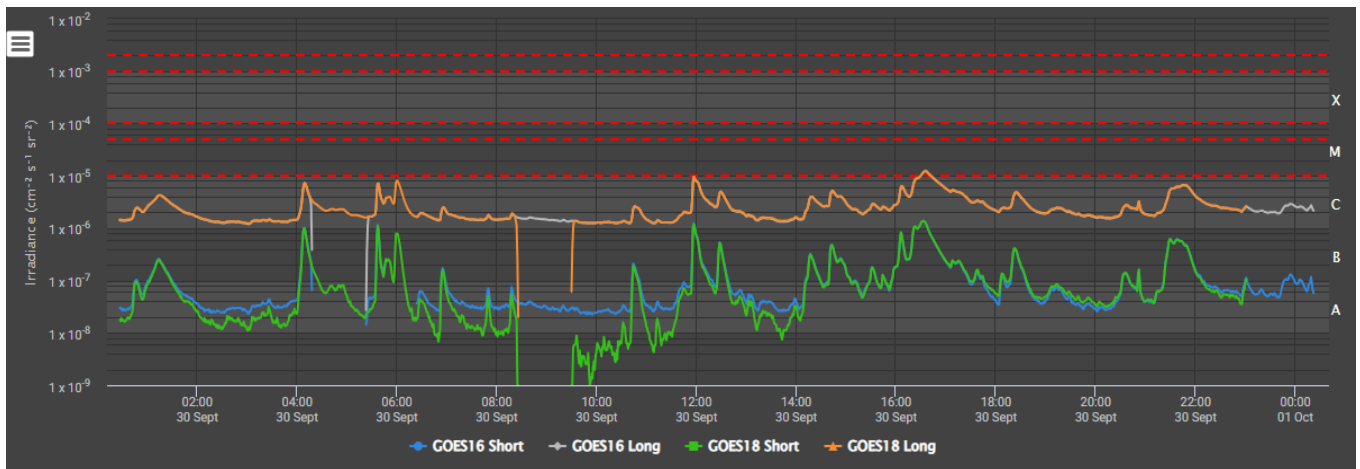
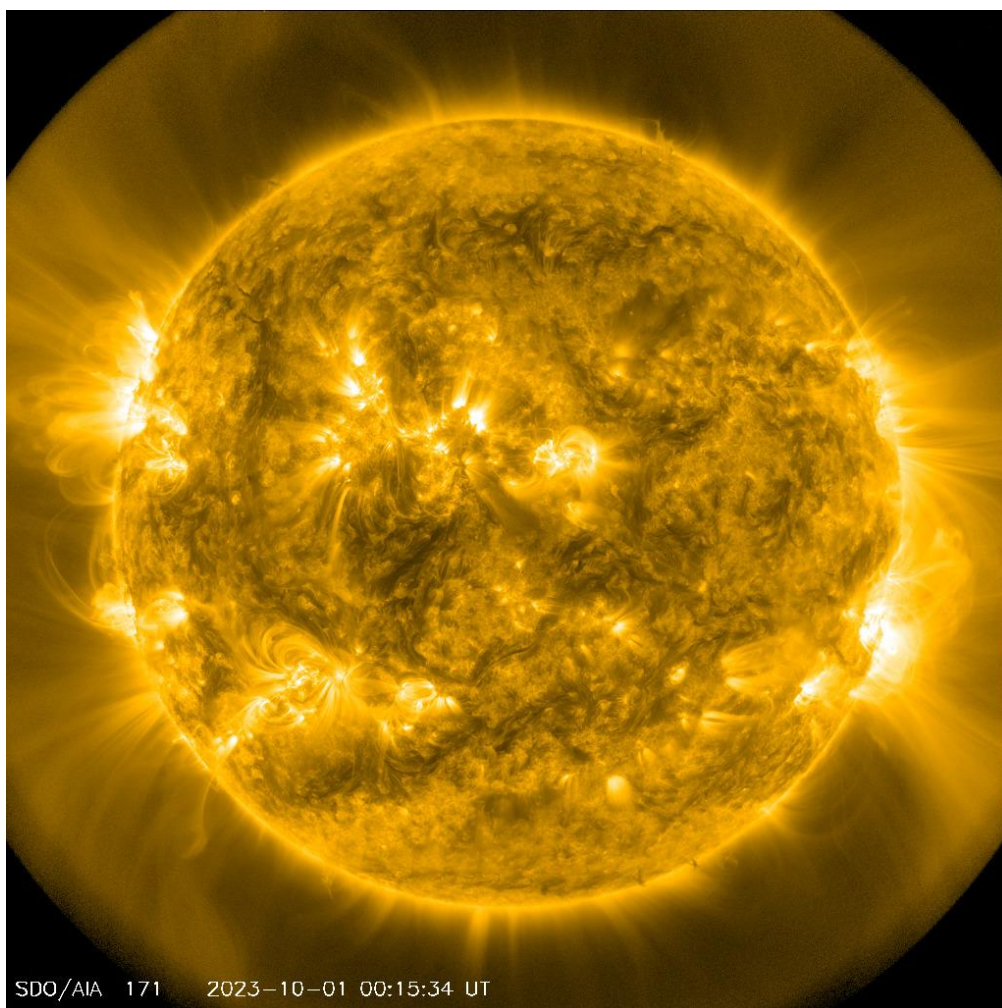


Figure 4: SDO AIA 171 imagery at 01/0015 UTC



Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux observed by GOES16 is expected to persist at background levels, with the current sunspots on the disc not expected to produce proton events.

Radiation Storms	Level (cm ⁻² sr ⁻¹ s ⁻¹)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	1	1	1	1
Very Active	≥ S3 *	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = cm⁻²sr⁻¹s⁻¹)

High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) observed by GOES16 is expected to vary between background and diurnally high levels on day 1 (01 Oct) and some of day 2 (02 Oct). Thereafter a more significant drop-out of electron flux is forecast to occur, related to the onset of any fast winds from CH54/+, however this is fairly low confidence with regards to timings. A positive response in electron flux is possible by day 4 (04 Oct), although could be short-lived as the fast wind of CH55/+ could again cause drop-out.

The fluence is just below Active levels to start day 1 (01 Oct) and is expected to remain below throughout on a generally decreasing trend. REFM is likely too high for its expected fluence on day 1 (01 Oct), but appears to offer good guidance for the remainder of the forecast period.

GEO Electron Environment	Level (cm ⁻² sr ⁻¹ day ⁻¹)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1x10 ⁸	Yes	30	10	1	5
Very Active	≥ 2 MeV ≥ 1x10 ⁹	No	1	1	1	1

Figure 5: GOES 16 >2MeV Electron flux (top) and associated Fluence with REFM (below)

